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(71) Applicant: CANON KABUSHIKI KAISHA
Ohta-ku, Tokyo (JP)

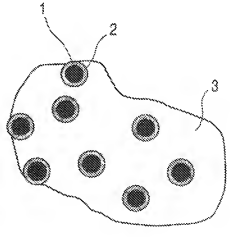
(72) Inventors:
- Yano, Tetsuya
  Tokyo (JP)
- Nomoto, Tsuyoshi
  Tokyo (JP)
- Kozaki, Shinya
  Tokyo (JP)
- Honma, Tsutomu
  Tokyo (JP)

(74) Representative: Weser, Wolfgang, Dr. Dipl.-Phys.
Weser & Kollegen,
Patentanwälte,
Radeckestrasse 43
81245 München (DE)

(54) Electrostatic charge image developing toner, producing method therefor, and image forming method and image forming apparatus utilizing the toner

(57) Electrostatic charge image developing toner allows to design the toner characteristics such as chargeability, flowability, stability in time and environmental stability uniform among the toners of different colors. The toner has a small particle size enough for enabling uniform dispersion and being excellent in color saturation and transparency. The toner also shows higher contribution to the environmental security. The toner includes a coloring agent of which at least a part of the surface is covered with polyhydroxyalkanoate (PHA). The toner is produced by dispersing the coloring agent in aqueous medium, then fixing PHA synthesizing enzyme to the coloring agent dispersed in the aqueous medium, then adding 3-hydroxyacyl CoA, and executing a PHA synthesizing reaction to cover at least a part of the surface of the coloring agent with PHA. The toner thus obtained is used for an image forming method.

FIG. 8



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while Fig. 9 is a cross-sectional view of a conventional toner particle. In case of the conventional toner, pigment 1 is dispersed in binder resin 4, but, in case of the present invention, pigment 1 is covered with first resin component 2 and is further dispersed in second resin component 3.

[0074] In the toner of the present invention, since the colorant covered with the outer shell resin is bound by the thermoplastic resin, the combination of the coloring agent contained in the colorant and the resin for binding the colorant is not limited and there can be obtained large freedom in the material selection. Also the coloring agent, for example pigment particles cause less migration to the exterior of the colorant (exposure to the surface of the colorant). Besides, the colorant, covered with the outer shell, can be produced with a sharper particle size distribution even in case of containing the coloring agent at a higher concentration. The interior of the colorant covered with polyhydroxyalkanoate generally consists of the coloring agent itself, and the coloring agent is preferably composed of pigment in consideration of the light fastness and antibleeding resistance of the coloring agent.

[0075] In the following there will be given a detail explanation on the aforementioned colorant.

«PHA»

[0076] The PHA to be employed in the present invention can be any PHA that can be synthesized by a PHA synthesizing enzyme relating to the PHA biosynthesizing reaction.

[0077] The biosynthesis of PHA is executed from various alkanoic acids as starting material by a polymerization reaction by an enzyme, utilizing, as the substrate, (R)-3-hydroxyacyl CoA generated through various metabolic paths (for example β-oxidation system or fatty acid synthesis path) in the organisms. The enzyme catalyzing such polymerization reaction is PHA synthesizing enzyme (also called PHA polymerase or PHA synthase).

[0078] CoA is an abbreviation for coenzyme A, having the aforementioned chemical structure. Also the reaction path from alkanoic acid to PHA through the β-oxidation system and polymerization reaction by the PHA synthesizing enzyme is as explained in the foregoing. On the other hand, in case of synthesis through the fatty acid synthesis path, PHA is assumed to be synthesized similarly by the PHA synthesizing enzyme, utilizing, as the substrate, (R)-3-hydroxyacyl CoA converted from (R)-3-hydroxyacyl ACP (ACP meaning acyl carrier protein) generated in such path. It is already known and reported, as explained in the foregoing, that PHA can be synthesized in a cell-free system (in vitro) by taking out the aforementioned PHB synthesizing enzyme or PHA synthesizing enzyme from the bacteria. As explained in the foregoing, the PHA synthesizing enzyme catalyzes the final stage in the PHA synthesizing reaction system in the organisms, so that any PHA known to be synthesizable in the organisms is synthesized by the catalyzing effect of such enzyme. Therefore, it is possible to prepare microcapsules formed by covering the coloring agent with any PHA known to be synthesizable in the organisms, by reacting 3-hydroxyacyl CoA corresponding to the desired PHA on the aforementioned enzyme fixed on the coloring agent of the present invention.

[0079] Specific examples of the PHA employable in the present invention include the aforementioned PHA. Specific examples of the aforementioned halogen atom include fluorine, bromine and chlorine. Also the aforementioned chromophore is not particularly limited as long as its 3-hydroxyacyl CoA bonding form can be catalyzed by the PHA synthesizing enzyme, but, in consideration of steric hindrance in the polymer synthesis, it is desirable, in the 3-hydroxyacyl CoA molecule, that a methylene chain with 1 to 6 carbon atoms is present between the carboxyl group bonded to CoA and the chromophore. Also the colored composition consisting of microcapsule pigment based on the PHA having such chromophore is expected, for example, to exhibit more effective color development by a composite action with the color developing component of the pigment.

[0080] Also as the PHA to be employed in the present invention, there can be utilized random copolymer or block copolymer including a plurality of the aforementioned monomer units, and there can be achieved control of the physical properties, realization of plural functions and realization of novel functions utilizing the properties of the monomer units or the functional groups contained therein or the interaction of such functional groups. It is also possible to synthesize, on the surface of the coloring agent, a block copolymer of arbitrary sequence and composition by suitably controlling the amount and order of addition of 3-hydroxyacyl CoA constituting the substrate. It is also possible, if necessary, to execute chemical modification after or during the PHA synthesis.

[0081] For example, it is possible to vary the monomer unit composition of PHA in a direction from the inner side to the outer side of the colorant, by changing in time the type and concentration of 3-hydroxyacyl CoA constituting the substrate. In this manner it is possible to form PHA showing higher mutual solubility with the binder resin in the outer surfacial layer of the colorant and to form PHA showing higher affinity with the coloring agent in the inner surfacial layer of the colorant, thereby enhancing the effect of the present invention. More specifically, in case PHA having mutual solubility with the binder resin shows low affinity with the coloring agent, there can be employed a process of at first covering the coloring agent with PHA showing higher affinity therewith and changing the monomer unit of the PHA toward higher mutual solubility with the binder resin from the inner side of the colorant to the outer side thereof for example in a multi-layered or gradient structure, thereby producing colorant showing stronger bonding with the coloring agent and having a PHA covering mutually soluble with the binder resin.

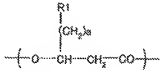
<210> 14
<211> 30
<212> DNA
<213> Artificial Sequence
<220>
<223> Primer for PCR multiplication
<400> 14
cgatctgag gcgcacgcgc acgtaagtcc 30

Claims

1. Electrostatic charge image developing toner comprising at least a colorant of which at least a part thereof is covered with polyhydroxyalkanoate constituting a first resin component, and binder resin constituting a second resin component.

2. Electrostatic charge image developing toner according to claim 1, wherein said colorant contains a pigment.

3. Electrostatic charge image developing toner according to claim 1 or 2, wherein said polyhydroxyalkanoate includes at least one selected from the group consisting of monomer units represented by the following formulas (1) to (10).



[1]

wherein the monomer unit is at least one selected from the group consisting of monomer units in which the combination of R1 and a is any of the following.

a monomer unit in which R1 is a hydrogen atom (H) and a is an integer from 0 to 10;
a monomer unit in which R1 is a halogen atom and a is an integer from 1 to 10;
a monomer unit in which R1 is a chromophore and a is an integer from 1 to 10;
a monomer unit in which R1 is a carboxyl group or a salt thereof and a is an integer from 1 to 10; and
a monomer unit in which R1 is a group represented by the following formula:

and a is an integer from 1 to 7;

kanoate is crosslinked polyhydroxyalkanoate

12. Electrostatic charge image developing toner according to claim 11, wherein said crosslinked polyhydroxyalkanoate is crosslinked from polyhydroxy alkanoate at least including a monomer unit having an epoxy group.

13. An image forming method including at least a step of externally applying a voltage to a charging member thereby charging an electrostatic latent image bearing member, a step of forming an electrostatic charge image on the charged electrostatic latent image bearing member, a development step of developing the electrostatic charge image with electrostatic charge image developing toner thereby forming a toner image on the electrostatic latent image bearing member, a transfer step of transferring the toner image on the electrostatic latent image bearing member onto a recording material, and a fixation step of heat fixing the toner image on the recording material, the method comprising the use of the electrostatic charge image developing toner according to any of claims 1 to 12

14. An image forming method according to claim 13, including at least a step of externally applying a voltage to a charging member thereby charging an electrostatic latent image bearing member, a step of forming an electrostatic charge image on the charged electrostatic latent image bearing member, a development step of developing the electrostatic charge image with electrostatic charge image developing toner thereby forming a toner image on the electrostatic latent image bearing member, a first transfer step of transferring the toner image on the electrostatic latent image bearing member onto an intermediate transfer member, a second transfer step of transferring the toner image on the intermediate transfer member onto a recording material, and a fixation step of heat fixing the toner image on the recording material, the method comprising the use of the electrostatic charge image developing toner according to any of claims 1 to 12

15. An image forming apparatus at least including means for externally applying a voltage to a charging member thereby charging an electrostatic latent image bearing member, means for forming an electrostatic charge image on the charged electrostatic latent image bearing member, development means for developing the electrostatic charge image with electrostatic charge image developing toner thereby forming a toner image on the electrostatic latent image bearing member, transfer means for transferring the toner image on the electrostatic latent image bearing member onto a recording material, and fixation means for heat fixing the toner image on the recording material, the apparatus comprising the use of the electrostatic charge image developing toner according to any of claims 1 to 12.

16. An image forming apparatus according to claim 15, at least including means for externally applying a voltage to a charging member thereby charging an electrostatic latent image bearing member, means for forming an electrostatic charge image on the charged electrostatic latent image bearing member, development means for developing the electrostatic charge image with electrostatic charge image developing toner thereby forming a toner image on the electrostatic latent image bearing member, first transfer means for transferring the toner image on the electrostatic latent image bearing member onto an intermediate transfer member, second transfer means for transferring the toner image on the intermediate transfer member onto a recording material, and fixation means for heat fixing the toner image on the recording material, the apparatus comprising the use of the electrostatic charge image developing toner according to any of claims 1 to 12.

17. A method for producing electrostatic charge image developing toner including a colorant obtained by covering at least a part of the surface of a coloring agent with polyhydroxyalkanoate constituting a first resin component, the method comprising execution of a polyhydroxyalkanoate synthesizing reaction utilizing 3-hydroxyacyl CoA as the substrate in the presence of a polyhydroxyalkanoate synthesizing enzyme fixed on the surface of a coloring agent dispersed in aqueous medium to cover at least a part of the surface of said coloring agent with polyhydroxyalkanoate thereby producing said colorant.

Toner

18. A method for producing electrostatic charge image developing toner according to claim 17 wherein said polyhydroxyalkanoate includes at least one selected from the group consisting of monomer units represented by the following formulas (1) to (10), and the respectively corresponding 3-hydroxyacyl coenzyme A is any of those represented by the chemical formulas (11) to (20):